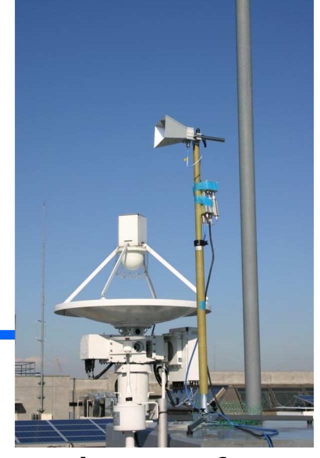
Radio Environment Survey at Kashima and Koganei

M. Sekido, K. Takefuji, R.Ichikawa, and H. Ujihara
National Institute of Information and Communications Technology(NICT)/Kashima, Japan



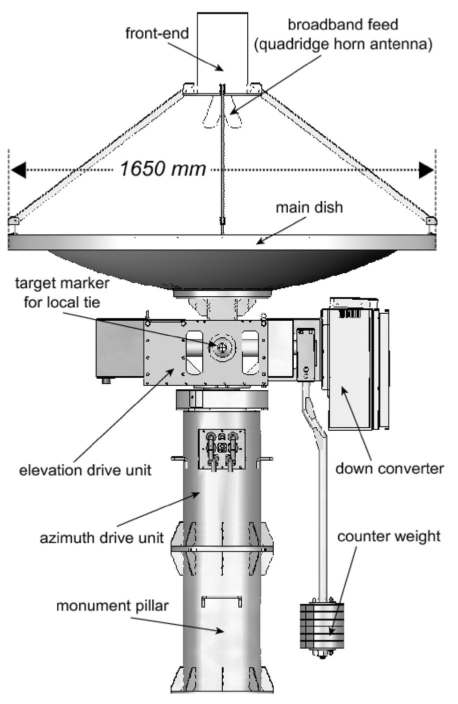
Abstract

RFI prevention is important issue for success of the VLBI2010. We experienced serious RFI with MARBLE system at Koganei(Tokyo) and Kashima. Finally we decided to use high pass filter (HPF) with Fc=3.5GHz to reduce the RFI problem. Since S-band is not used in this case, we need to have discussion and agreement for the common observation frequency range for implementation of VLBI2010. We used to use synthesized circular polarization from linear polarization output from QRH-antenna in current MARBLE, though phase control will become more difficult when using HPF. Cooling of HPF and LNA should be considered and new correlation software for linear polarization is required.

1.Introduction and motivation

VLBI2010 specifications suppose to use wide band (2-14GHz) receiver for high precision delay measurements. However wide band receiver is vulnerable to radio frequency interference (RFI).

NICT and Geospatial Information Authority of Japan(GSI) have developed portable small diameter antenna system for baseline length validation by VLBI, which is named MARBLE.(Fig.1). We have a plan to use it for T&F transfer via VLBI. First prototype MARBLE-1 is located at the roof of 34m antenna office building, and the 2nd MARBLE-2 originally built at Tsukuba has been moved to the roof of 2nd-building at Koganei Headquarter of NICT in 2010 (Fig.2). After that movement, system performance of MARBLE-2 degraded, and its cause was suspected to be due to RFI. For basic workaround to the problem, introduction of high-pass filter (HPF) in front of LNA seemed to be inevitable. For the purpose to fix the cut-off frequency of HPF, we have made radio frequency environment survey at Kashima and Koganei, where each MARBLE antennas are located.



Antenna type	Front-feed parabola
Diameter of antenna	1.5 – 1.9m
Mount style	Az-El mount
Receiving frequency	S-band 2215-2300 MHz X-band 8180-9080 MHz
Feed	Broad-band Feed (QRHA)
Driving speed	5° ／sec
Tsys	S-band ～200 K X-band ～160K

Fig. 1 MARBLE antenna is designed for baseline length validation by inter comparison between VLBI and GPS. Azimuth drive unit and above can be removed and GPS receiver is placed on the monument pillar for collocation observation.

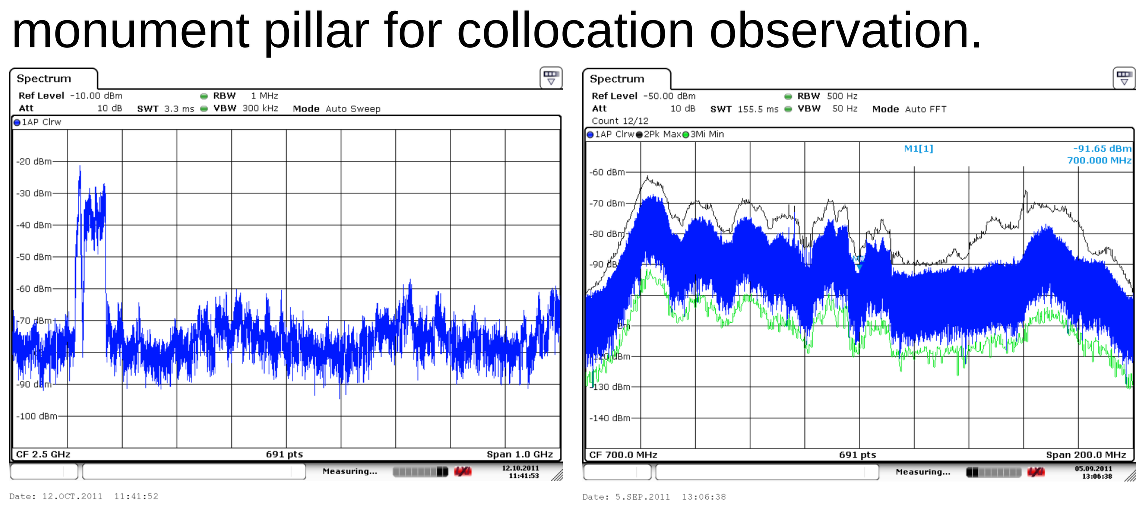


Fig.3 Example of distorted IF Band spectrum for S-band(left) and X-band(right) of MARBLE-2 antenna at Koganei.

2.RFI Environment Survey at Kashima and Koganei

RFI survey was made with broad band receiver system (SIRIUS) of Fig. 4. Locations of RFI surveys are displayed in Fig. 2. Measurement results at point-1 and point-2 is indicated in Fig.5. At point-3(Kashima), measurement was made with both SIRIUS and LNA output of MARBLE for comparison (Fig.6). Fig.6 shows the RFI received by MARBLE is less than that of SIRIUS due to the directivity of parabola antenna. Each plots are vertically shifted to be distinguished each other. Identified sources of RFI are indicated on Fig.7.

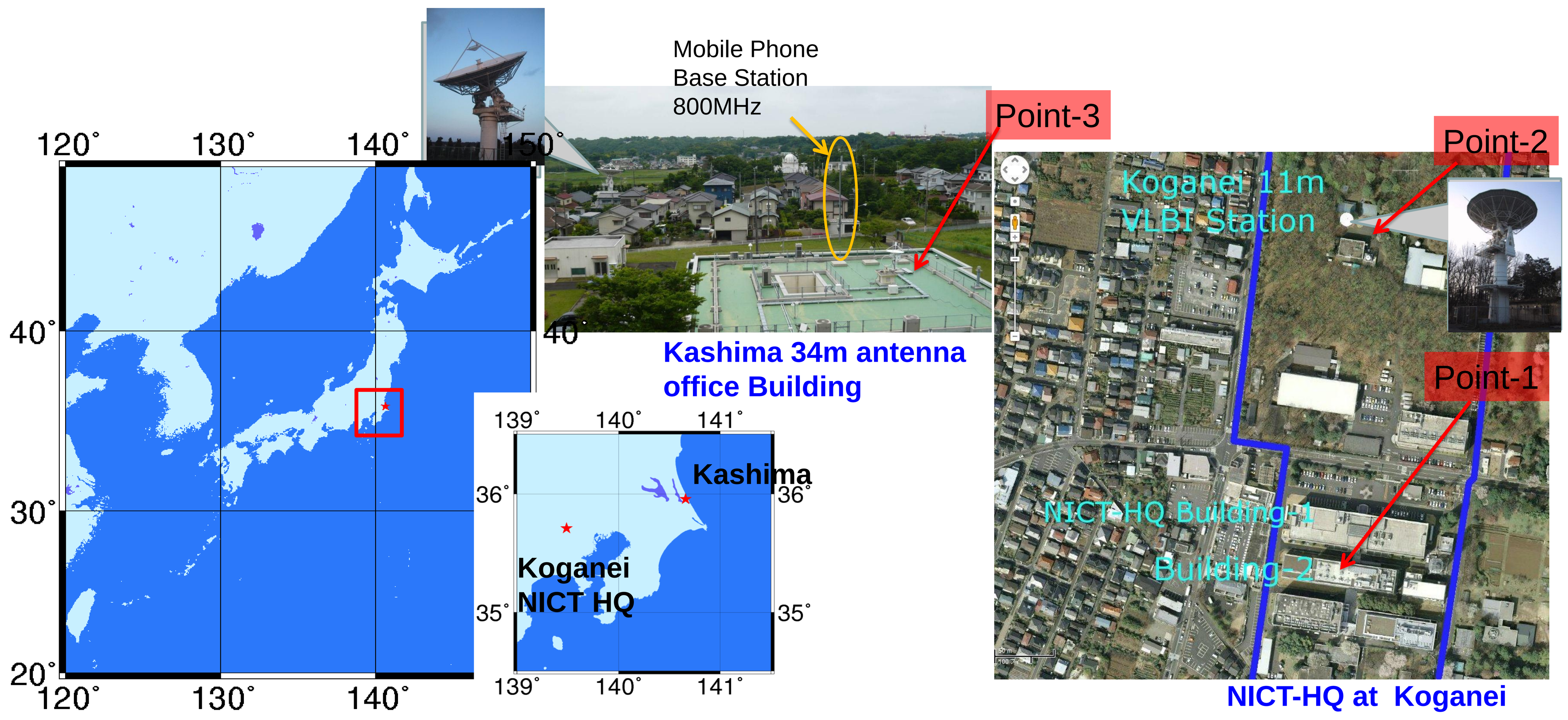


Fig.2 Locations of Kashima Space Technology Center(KSTC) and Koganei NICT-HQ are indicated on the map (left). Pictures(right) shows the location of RFI survey points at Koganei and Kashima. **Point1**:Roof of the building-2 at Koganei-HQ, where atomic standards lab is located. **Point2**:Roof of the Koganei11m VLBI station operation building. **Point3**:Roof of the 34m antenna office building at Kashima.

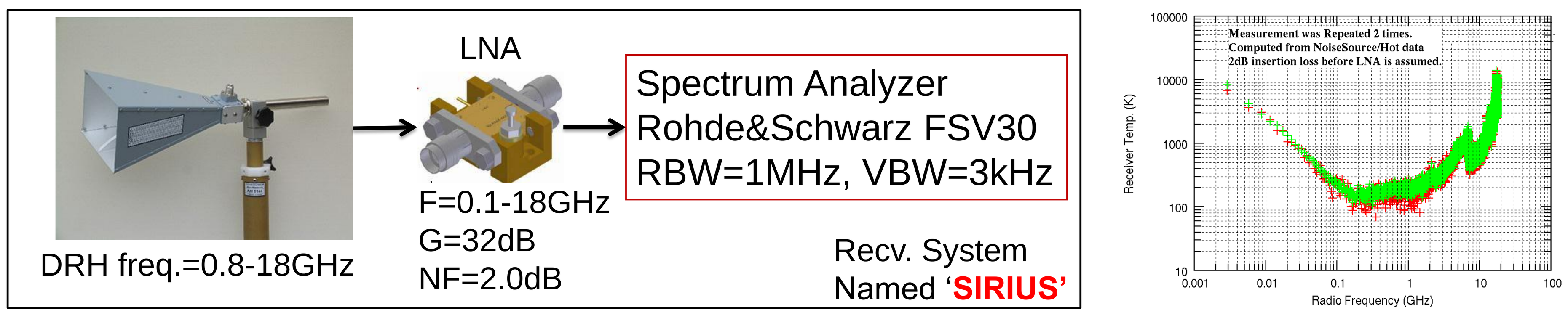


Fig.4 RFI survey was made with combination of Broadband antenna, broadband LNA and spectrum analyzer. Trx-Frequency characteristic measured via noise source is displayed at right panel.

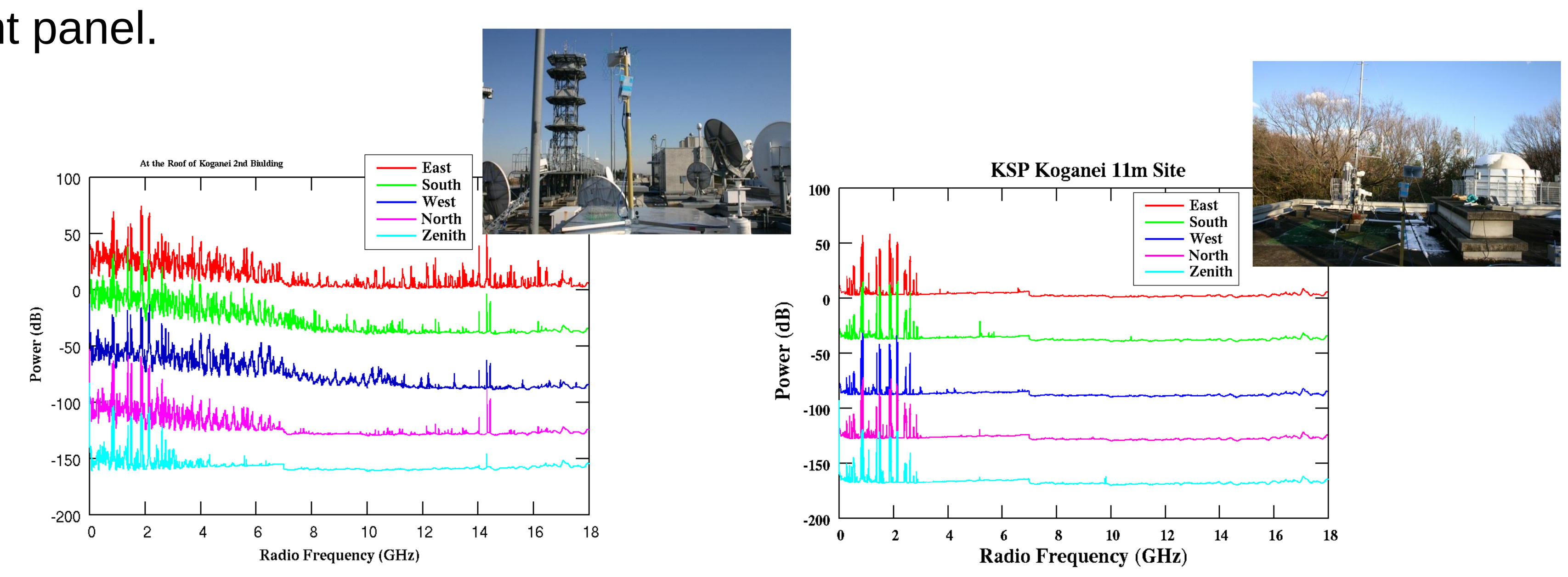


Fig.5 Radio environment survey was made at three locations(Fig.2) with directing the SIRIUS antenna(Fig.4) to horizontal directions (East, South, West, North). Observation frequency range was 0-18GHz. Results at **Point1** (left) and **Point2** (right) are displayed with pictures of the views at each locations. Significant RFI above 3GHz at point-1 was found to be emitted from labs inside NICT. Point-2 (VLBI11m site) was better than point-1, though condition of RFI lower than 3GHz was almost the same with point-1.

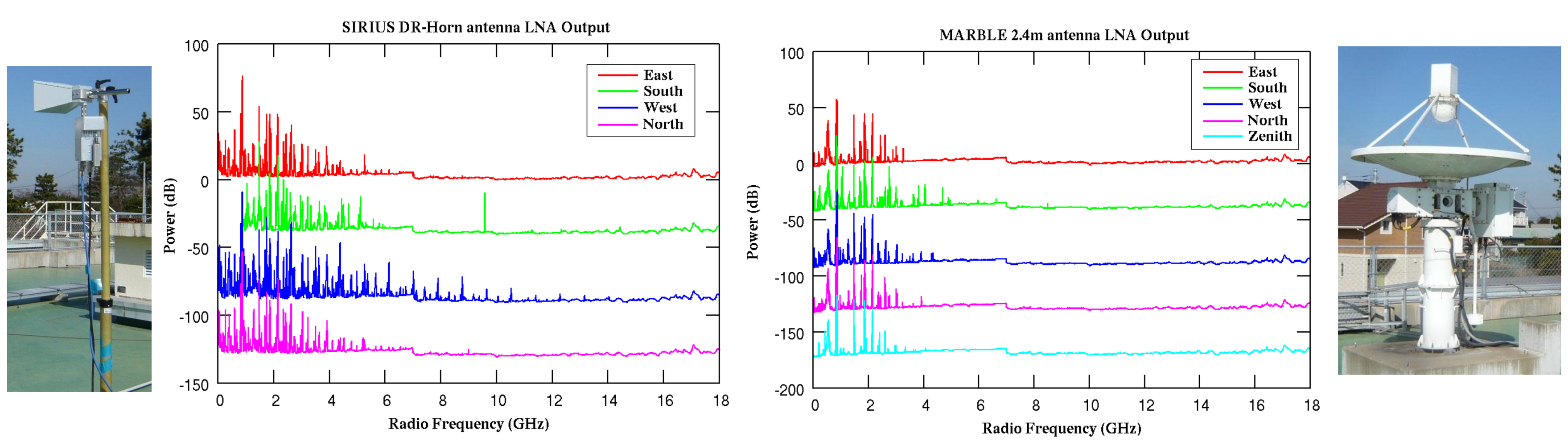


Fig.6 RFI signal received with SIRIUS at point-3(Kashima). Due to smaller beam size, MARBLE was a little less suffered from RFI than SIRIUS. Inter-modulation phenomena in the LNA has been observed for SIRIUS in west direction.

3. Summary & Discussion.

A) RFI is quite severe at radio frequency below 3GHz, and it will become worse by spread use of smart-phone and wireless-LAN.

B) Frequency range above 3GHz is fairly quiet even in Tokyo and feasible to use them for interferometry observation.

C) We are going to use HPF(3GHz) before LNA to prevent LNA saturation in MARBLE. Maybe consideration of cooling of LNA and HPF should be necessary to minimize the increase of Trx due to HPF insertion

D) Common observation frequency band for VLBI2010 is very important for implementation and may be necessary to fix some candidate bands for IF amplification. Because amplifying all the received band is vulnerable to saturation before sampler. Choosing LNA with higher saturation capacity will be preferable.

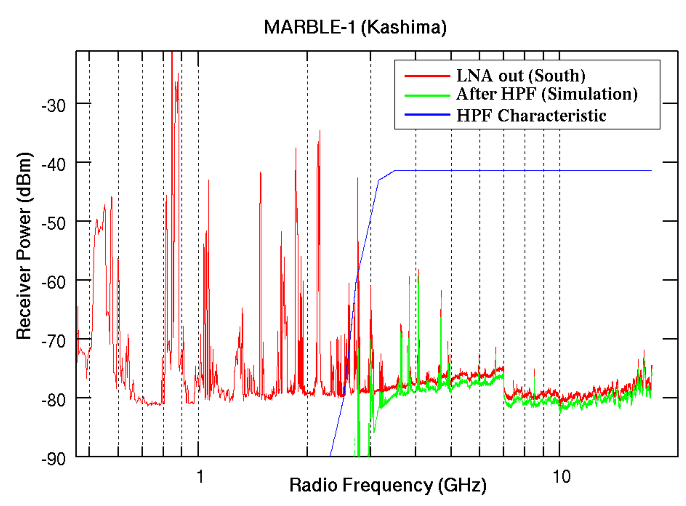
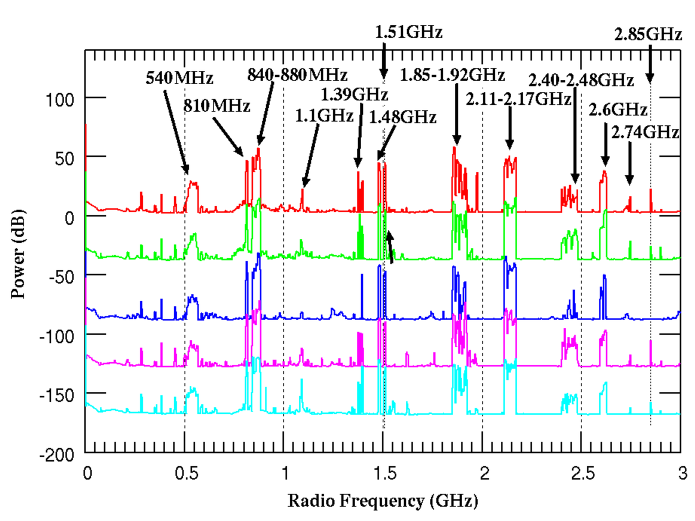


Fig.8 Insertion of HPF in front of LNA is our current workaround for the RFI below 3GHz. Cooling of filter and LNA is to be considered to prevent increase of Trx.



Freq.	Source
540MHz	TV broadcast
810MHz	Mobile Phone
840-880M	Mobile Phone
1.1GHz	Aeronautical radio
1.39GHz	Rader?
1.48GHz	Mobile phone
1.51GHz	MCA?
1.85-1.92G	PHS
2.11-2.17G	Mobile Phone
2.40-2.48G	Wireless LAN

Fig.7 Identified sources of RFI from frequency allocation data of Radio Regulatory Bureau of Japan.